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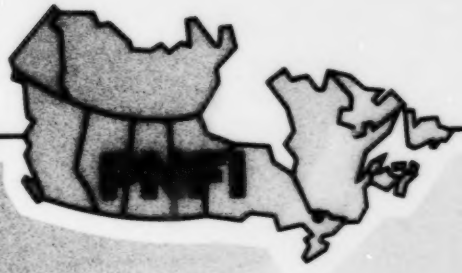
# Canadian conifer forest tree seed statistics: 1982-1983 survey results

P.S. Janas

Information Report PI-X-56
Petawawa National Forestry Institute



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# CANADIAN CONIFER FOREST TREE SEED STATISTICS: 1982-83 SURVEY RESULTS

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## ABSTRACT

Results of a 1982-83 national forest tree seed survey are presented. Jack pine, white spruce, and black spruce continue to be the most important and widely used reforestation species in Canada, accounting for 43%, 24%, and 18% of total seed used in reforestation, respectively. Each of these species was the leading forestry species in terms of seed used in three provinces. Compared to the 1980-81 survey, quantities of cones collected and processed and seed in storage are substantially higher on a national scale, whereas the amount of seed used in reforestation programs dropped by 7.3% to 5.3 billion seeds. Approximately 87.5% of seed of major reforestation species originated from unimproved natural stands, 12.4% came from seed collection and production areas, and only 0.2% was collected from seed orchards, these figures being virtually unchanged from the previous survey. Fourteen seed extraction plants, three of which are privately owned, processed forest tree seed in 1982-83. Most of the 12 plants having seed storage facilities reported that their conifer seed had moisture contents in storage of 6% and were stored in heavy- walled polyethylene containers at subfreezing temperatures.



## KEYWORDS

National survey, tree seed statistics, seed extraction plants.



## RÉSUMÉ

Des résultats sont présentés d'une étude nationale réalisée en 1982-1983 sur les semences d'arbres forestiers. Le pin gris, l'épinette blanche et l'épinette noire continuent de figurer au premier rang des essences employées pour le reboisement au Canada (respectivement 43, 24 et 18 % de toutes les graines utilisées à cette fin). Chacune de ces essences dominait dans trois provinces au chapitre du nombre de semences utilisées. Par rapport à l'étude de 1980-1981, les quantités de cônes cueillis et traités et de semences entreposées sont sensiblement plus élevées à l'échelle nationale, tandis que le nombre de graines utilisées pour les programmes de reboisement a baissé de 7,3 % pour s'établir à 5,3 milliards. Environ 87,5 % des semences des principales essences de reboisement provenaient de peuplements naturels non améliorés, 12,4 % de peuplements utilisés pour la production et la récolte de graines et seulement 0,2 % de vergers à graines; ces statistiques n'ont pratiquement pas changé depuis la dernière étude. Quatorze usines d'extraction des semences, dont trois privées, ont traité des graines d'essences forestières en 1982-1983. La plupart des douze usines équipées d'installations d'entreposage ont indiqué que leurs semences de conifères entreposées avaient une teneur en humidité de 6 % et qu'elles étaient conservées à des températures au-dessous du point de congélation dans des contenants de polyéthylène aux parois épaisses.



## MOTS CLÉS

Étude nationale, statistiques concernant les semences d'arbres, usines d'extraction des semences.

# CANADIAN CONIFER FOREST TREE SEED STATISTICS: 1982-83 SURVEY RESULTS

## INTRODUCTION

This second national seed statistics survey has been prepared as part of the Canadian Forestry Services' FORSTATS (Forestry Statistics) program, which endeavours to provide statistical information on Canada's forest resources together with related economic, social, and environmental data. All provincial forestry agencies, other provincial and federal departments, as well as the forest industry cooperate in providing data for this program. This report is an update of a similar survey, Canadian Forest Tree Seed Statistics: 1980-81 Survey Results, by P.S. Janas and B.D. Haddon, published in 1984. Frequent references to this publication will be made in this report.

Success of reforestation efforts are influenced not only by seed quantity, physiological quality, and sowing strategies, but also by the species used. In addition to presenting the nature, magnitude, and scope of seed procurement, processing, utilization, and storage programs in Canada, this report will determine:

(1) the most important and widely used species in Canada in regeneration activities and those which are of greatest significance in each province; and
(2) the degree to which seed requirements are satisfied by various types of seed production strategies.

Less than 0.1% of the seed used in forestry activities for the 1982-83 period comprised hardwood species. A large portion of this seed was used in activities such as wildlife habitat amelioration and urban forestry, which are not synonymous with forest regeneration. Therefore, this report will limit discussion to conifer species.

This report does not include statistics on tree seed collected and processed for export because of the proprietary nature of the information.

An up-to-date directory of seed extraction plants and associated seed storage facilities is provided in Appendix I and is briefly discussed in the report.

## METHODOLOGY

Data were gathered by means of a questionnaire distributed to provincial forestry agencies (Appendix II) and the reporting period for all provinces was fiscal year 1982/83. Some of the information presented in the Tree Seed Extraction Plant Directory (Appendix I) was obtained from a national survey of seed storage facilities conducted for the International Board for Plant Genetic Resources by this report's author. Common names are used throughout the text; scientific names are provided in Table 1.

**Table 1. Conifer species used for forest regeneration or establishment in Canada in 1982/83 (excluding species which are vegetatively propagated)**

| Scientific Name | | |
|---|---|---|
| Genus | Species | Common Name |
| *Abies* | *amabilis* | amabilis fir |
| | *balsamea* | balsam fir |
| | *grandis* | grand fir |
| | *lasiocarpa* | alpine fir |
| *Chamaecyparis* | *nootkatensis* | yellow cypress or cedar |
| *Larix* | *decidua* | European larch |
| | *eurolepis* | Dunkeld larch |
| | *laricina* | tamarack |
| | *leptolepis* | Japanese larch |
| | *occidentalis* | western larch |
| | *sibirica* | Siberian larch |
| *Picea* | *abies* | Norway spruce |
| | *engelmannii* | Engelmann spruce |
| | *general*[1] | interior spruce |
| | *glauca* | white spruce |
| | *mariana* | black spruce |
| | *pungens* | blue spruce |
| | *rubens* | red spruce |
| | *sitchensis* | Sitka spruce |
| *Pinus* | *banksiana* | jack pine |
| | *contorta* | lodgepole pine |
| | *monticola* | western white pine |
| | *mugo* | mugho pine |
| | *nigra* | Austrian pine |
| | *ponderosa* | ponderosa pine |
| | *resinosa* | red pine |
| | *strobus* | eastern white pine |
| | *sylvestris* | Scots (Scotch) pine |
| *Pseudotsuga* | *menziesii* | Douglas-fir |
| *Thuja* | *occidentalis* | eastern white cedar |
| | *plicata* | western red cedar |
| *Tsuga* | *canadensis* | eastern hemlock |
| | *heterophylla* | western hemlock |
| | *mertensiana* | mountain hemlock |

[1]British Columbia: defined as a "mixture of pure spruce seedlots and various *glauca* x *engelmannii* hybrids"

## RESULTS AND DISCUSSION

### National perspective

Cones of 34 conifer species were collected throughout Canada for forest regeneration purposes in 1982/83 (Table 1). The cones yielded 14.3 billion viable seeds, of which 5.3 billion were used in direct seeding and planting programs. Seed yield from processed cones exceeded total seed utilized by 171%. Approximately 38.3 billion seeds were in storage at the end of 1982-83 (Table 2). Over 85% of the total volume of conifer cones collected were in Alberta, Ontario, and Québec and these provinces accounted for 80% of total seed used in Canada.

On a national basis, the quantities of cones collected and processed and seed in storage are substantially higher than reported in 1980-81 data, probably as a result of heavy seed crops in many areas of Canada during 1982. Despite this, the amount of seed used in reforestation programs is lower (by 7.3% or 414 million seeds) than reported in the previous period, with the likely explanation being limited financial resources for planting programs. As the last survey indicated, annual seed usage must increase by 4% per annum to meet projected seed requirements in 1987. This decline in seed usage suggests that future reforestation targets may not be achieved unless seed usage from 1982 to 1987 increases by 6.6% per annum. Seed supply is not a limiting factor because, if we assume no future collections and approximately equal seed reserve to seed use ratios for all species, an estimated 6.1 years of supply for all major* species exists (Table 3) assuming seed use increases by 5% annually. If years of seed supply are compared to seed crop periodicity, seed reserves of all species, excepting jack pine, are satisfactory. Relatively low inventories of jack pine are maintained because cones of this species can be collected year round and also because cones up to six years old can be collected with satisfactory viable seed yields (Baker 1980).

As in the last survey, the number of seeds used for reforestation is used as the criterion for determining the most important reforestation species. On this basis, the 10 most important reforestation species are listed in Table 4. The results indicate that the ranking for the first five species is the same as for 1980-81. Jack pine is used more extensively in direct seeding than any other species. For example, Yeatman (1984) reports that in Ontario alone, 94% of jack pine seed is direct seeded. Consequently, the percentage of jack pine seed used overestimates its reforestation importance in terms of total forest area regenerated. Red spruce and western hemlock, both in last place on the previous list, have been replaced by Engelmann spruce and Norway spruce, the latter being the first exotic judged to be among Canada's top reforestation species.

If the number of seedlings shipped in 1982 (from Smyth and Brownwright 1984) are compared with seed production among the provinces, notable differences appear among provinces. For instance, while British Columbia ranks in fifth place in seed use (Table 2), it had the largest number of seedlings shipped (127.4 million) of all provinces in that year. Québec, which ranked 4th in total seedlings shipped in 1982 (40.3 million), used

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*Major species in this report include those accounting for at least 1% of total seed utilized in Canada (from Table 4).

**Table 2. Quantities of cones and seeds of coniferous species collected, processed, utilized, and stored in Canada for reforestation purposes in 1982/83**

| Province | Number of conifer species | Volume of cones collected (hl) | Seed yield from cones processed | | Seed utilized | | Seed in storage | |
|---|---|---|---|---|---|---|---|---|
| | | | kg | viable seed x $10^6$ | kg | viable seed x $10^6$ | kg | viable seed x $10^6$ |
| Alberta | 2 | 24 237 | 9239 | 2959.8 | 3199 | 895.2 | 41 104 | 11383.6 |
| British Columbia | 16 | 9012 | 8964 | 2482.1 | 1969 | 346.6 | 39 042 | 7512.5 |
| Manitoba | 9 | 527 | 397 | 68.6 | 92 | 27.5 | 1013 | 249.3 |
| New Brunswick | 10 | 1788 | 3343 | 705.3 | 1067 | 350.4 | 6259 | 1804.6 |
| Newfoundland | 2 | 427 | 109 | 40.4 | 92 | 55.5 | 745 | 427.7 |
| Nova Scotia | 9 | 795 | 621 | 156.4 | 348 | 80.4 | 1349 | 208.2 |
| Ontario | 17 | 40 296 | 15 283 | 5255.3 | 9635 | 2415.9 | 38 671 | 10157.5 |
| Prince Edward Is. | 5 | 135 | 263 | 34.6 | 35 | 9.4 | 286 | 41.6 |
| Québec | 11 | 16 173 | 8529 | 2081.4 | 4274 | 918.3 | 20 113 | 4049.2 |
| Saskatchewan | 2 | 898 | 1212 | 555.8 | 474 | 191.6 | 5681 | 2461.6 |
| Totals (Canada) | 34 | 94 288 | 47 960 | 14339.7 | 21 185 | 5290.8 | 154 263 | 38295.8 |
| % increase over | 1980/81 | 88.6 | 72.5 | 88.1 | -23.0 | -7.3 | 26.1 | 37.2 |

**Table 3. Seed supply for major reforestation species based on 5% annual increase in seed utilization and 1982/83 seed statistics**

| Species | Amount of seed utilized as % of seed in storage | Years of supply[1] | Seed crop periodicity (years)[2] | Surplus (+) deficit[3] (-) |
|---|---|---|---|---|
| Douglas-fir | 5.1 | 14.1 | 6 | + |
| lodgepole pine* | 6.2 | 12.0 | 2 | + |
| red pine | 14.9 | 5.9 | 5 | + |
| jack pine* | 40.3 | 2.4 | 3 | - |
| eastern white pine | 12.9 | 6.7 | 4 | + |
| black spruce | 19.9 | 4.6 | 4 | + |
| Engelmann spruce | 3.7 | 17.4 | 4 | + |
| interior spruce | 4.0 | 16.6 | 4 | + |
| Norway spruce | 39.4 | 2.4 | 2 | + |
| white spruce | 7.9 | 10.1 | 4 | + |

*serotinous species: cones can be collected year-round.

[1]using 5% annual increase and $b = \frac{a(1-1.05^n)}{1-1.05}$

where a = current seed use
b = total seed in storage
n = no. of years

[2]from: Wang 1974.

[3]comparing years of supply to seed crop periodicity and assuming no further seed collections.

**Table 4. Ten most important forestry species in Canada based on total viable seed used in reforestation in 1982/83**

| | % of total conifer seed utilized | Rank in 1980/81 survey (1=highest) |
|---|---|---|
| jack pine | 43.0 | 1 |
| white spruce | 23.6 | 2 |
| black spruce | 17.8 | 3 |
| lodgepole pine | 4.2 | 4 |
| interior spruce | 1.6 | 5 |
| white pine | 1.5 | 7* |
| Norway spruce | 1.1 | - |
| Douglas-fir | 1.0 | 6 |
| red pine | 1.0 | 7* |
| Engelmann spruce | 1.0 | - |

*same amount of seed utilized in 1980/81.
-not in previous survey's list.

**Table 5. Species with most widespread use in Canada's reforestation programs**

| | Provinces reporting use in forestry program | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | ALTA | BC | MAN | NB | NFLD | NS | ONT | PEI | QUE | SASK |
| white spruce | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| black spruce | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| jack pine | | | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ |
| red pine | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| balsam fir | | | ✓ | ✓ | | ✓ | | ✓ | ✓ | |
| Japanese larch | | | | ✓ | | ✓ | ✓ | | ✓ | |
| tamarack | | | | ✓ | | | ✓ | ✓ | ✓ | |
| eastern white pine | | | | ✓ | | ✓ | ✓ | | ✓ | |
| red spruce | | | | ✓ | | ✓ | ✓ | | ✓ | |
| Norway spruce | | | | | | ✓ | ✓ | | ✓ | |

the second largest number of seeds. Again, Ontario produced 25% fewer seedlings in 1982 than B.C., but used seven times as much seed in its reforestation program. All of this indicates that seed use strategies (direct-seeding or planting) vary considerably among the provinces and that the amount of seed used does not necessarily reflect the magnitude or nature of a given province's reforestation program.

The 10 species with the most widespread use in provincial forestry programs are listed in Table 5. Six of these species are also among the 10 most important in Canada (Table 4). The only notable changes since the last survey are that use of white spruce is now reported in all provinces, while Scots pine, previously reported in four provinces in 1980-81, is no longer included in this table (because it is used in fewer than three provinces).

**Provincial statistics**

Provincial statistics for Canada's major forestry species are summarized in Table 6. The most important reforestation species in each province (accounting for at least 1% of total provincial seed used) are summarized in Figure 1. Data for this graph are found in Appendix III.

Based on number of seed used, black spruce, white spruce, and jack pine are the leading forestry species in Canada. Black spruce is the primary species in three provinces (NB, NFLD, NS), white spruce in three (ALTA, PEI, SASK), and jack pine in three (MAN, ONT, QUE) (Fig. 1).

Yield of seed in kg/hL from cones processed continues to vary considerably between provinces, particularly in jack pine, red pine, black spruce, and white spruce. Much of the intraspecific variation is associated with genetic variability in seed crop quality and regional differences in cone size and yield. Different techniques and conditions used for seed extraction and cleaning may also contribute to these disparities.

The data for red pine indicates that seeds used in the review period exceeded seeds collected and processed in provinces east of Manitoba. This is likely due to a mediocre crop in most areas of eastern Canada in 1982.

**Main seed production strategies**

Table 7 shows that genetic tree improvement programs continue to contribute very small amounts of seed to reforestation efforts, with 0.2% of total seed originating from seed orchards. This genetically improved seed represents only one species - Douglas-fir. Only 12.4% of total quantity of seed for the leading reforestation species was obtained from seed production and collection areas, while 87.5% came from general or seed zone collections.

Results of the current survey are only marginally different than those reported for 1980-81. However, these figures should change gradually in the future when established seed orchards come into full production. Using viable seed yield per seed orchard ramet (C. Bartram, B.C. Min. Forests, pers. comm.; Corriveau 1978; Ying et al. 1985) and estimating viable seed per

**Table 6. Volumes of cones collected, seed yields, seed utilized, and seed in storage for major commercial species during 1982/83**

| Species | Province | Volume collected (hl) | Yield[1] | | | Seed utilized | | Seed in storage | |
|---|---|---|---|---|---|---|---|---|---|
| | | | kg | kg/hl | viable seed/hl | kg | viable seed x $10^6$ | kg | viable seed x $10^6$ |
| Douglas-fir | British Columbia | 3170 | 2446 | 0.77 | 65 440 | 606 | 51.4 | 11 958 | 1014 |
| lodgepole pine | Alberta | 18 241 | 2660 | 0.21 | 61 190 | 623 | 152 | 10 619 | 2590 |
| | British Columbia | 1394 | 407 | 0.29 | 75 410 | 283 | 73.2 | 3894 | 1005.7 |
| | Totals | 19 635 | 3067 | | | 906 | 225.2 | 14 513 | 3595.7 |
| | Weighted mean | | | 0.22 | 62 630 | | | | |
| red pine | Manitoba | 306 | 286 | 0.94 | 71 070 | 15 | 1.6 | 299 | 23.0 |
| | New Brunswick | 0.4 | 11 | N/A | - | 18 | 7.6 | 34 | 3.4 |
| | Nova Scotia | - | - | - | - | 30 | 1.5 | 100 | 8.9 |
| | Ontario | 203 | 120 | 0.60 | 62 320 | 244 | 25.4 | 2163 | 225.2 |
| | Prince Edward Is. | - | - | - | - | 16 | 1.7 | 14 | 1.5 |
| | Québec | 260 | 82 | 0.31 | 34 000 | 145 | 15.6 | 531 | 55.2 |
| | Totals | 769 | 499 | | | 468 | 53.4 | 3141 | 317.2 |
| | Weighted mean | | | 0.64 | 56 190 | | | | |
| jack pine | Manitoba | 67 | 34 | 0.51 | 120 610 | 37 | 9.7 | 396 | 95.8 |
| | New Brunswick | 306 | 167 | 0.54 | 150 080 | 274 | 72.5 | 167 | 45.9 |
| | Nova Scotia | - | - | - | - | 4 | 1.0 | 167 | 29.6 |
| | Ontario | 22 107 | 6590 | 0.47 | 109 900 | 6908 | 1574.5 | 16 272 | 4068 |
| | Québec | 5797 | 2551 | 0.44 | 110 800 | 2432 | 582.1 | 6480 | 1569 |
| | Saskatchewan | 37 | 18 | 0.47 | 123 590 | 136 | 35.7 | 802 | 210.5 |
| | Totals | 28 314 | 9360 | | | 9791 | 2275.5 | 24 284 | 6018.8 |
| | Weighted mean | | | 0.46 | 110 830 | | | | |

[1]Calculation based on volume of cones processed in reporting year, not necessarily volume collected in that year.
N/A not available
- nil

Table 6. (continued)

| Species | Province | Volume collected (hl) | Yield[1] kg | Yield[1] kg/hl | Yield[1] viable seed/hl | Seed utilized kg | Seed utilized viable seed x $10^6$ | Seed in storage kg | Seed in storage viable seed x $10^6$ |
|---|---|---|---|---|---|---|---|---|---|
| eastern white pine | Manitoba | - | - | - | - | - | - | 0.3 | 0.01 |
| | New Brunswick | 20 | 146 | 0.76 | 33 130 | 12 | 0.7 | 259 | 11.2 |
| | Nova Scotia | - | - | - | - | 4 | 0.1 | 100 | 2.4 |
| | Ontario | 3034 | 1070 | 0.78 | 25 960 | 1583 | 67.3 | 6386 | 271.4 |
| | Québec | 3045 | 2538 | 0.83 | 30 330 | 243 | 11.1 | 7487 | 316.8 |
| | Totals | 6099 | 3754 | | | 1842 | 79.2 | 14232.3 | 601.8 |
| | Weighted mean | | | 0.82 | 29 150 | | | | |
| black spruce | Manitoba | 123 | 44 | 0.36 | 280 490 | 10 | 7.5 | 55 | 47.3 |
| | New Brunswick | 584 | 479 | 0.82 | 549 880 | 284 | 197.9 | 1618 | 1051.7 |
| | Newfoundland | 282 | 7 | 0.57 | 345 360 | 90 | 55.0 | 645 | 392.2 |
| | Nova Scotia | 207 | - | - | - | 70 | 49.6 | 121 | 75.5 |
| | Ontario | 7202 | 1222 | 0.38 | 340 280 | 842 | 512.0 | 3410 | 2073.3 |
| | Prince Edward Is. | 38 | 21 | 0.55 | 333 370 | 4 | 2.7 | 31 | 19.0 |
| | Québec | 4580 | 1155 | 0.25 | 178 430 | 142 | 115.0 | 1361 | 1010.9 |
| | Totals | 13 016 | 2928 | | | 1442 | 939.7 | 7241 | 4669.9 |
| | Weighted Mean | | | 0.34 | 267 220 | | | | |
| Engelmann spruce | British Columbia | 1244 | 1146 | 0.92 | 297 000 | 160 | 51.4 | 4295 | 1384.4 |
| interior spruce | British Columbia | 1141 | 1003 | 0.88 | 284 300 | 268 | 86.8 | 6676 | 2161.5 |
| Norway spruce | Ontario | 266 | 251 | 2.66 | 89 570 | 90 | 8.6 | 427 | 40.6 |
| | Nova Scotia | 2 | 2 | 1.00 | 54 800 | 33 | 3.1 | 28 | 2.4 |
| | Québec | 815 | 650 | 0.80 | 74 200 | 470 | 48.5 | 1048 | 99.6 |
| | Totals | 1083 | 903 | | | 593 | 60.2 | 1503 | 142.6 |
| | Weighted Mean | | | 0.83 | 77 940 | | | | |

[1]Calculation based on volume of cones processed in reporting year, not necessarily volume collected in that year.

N/A not available

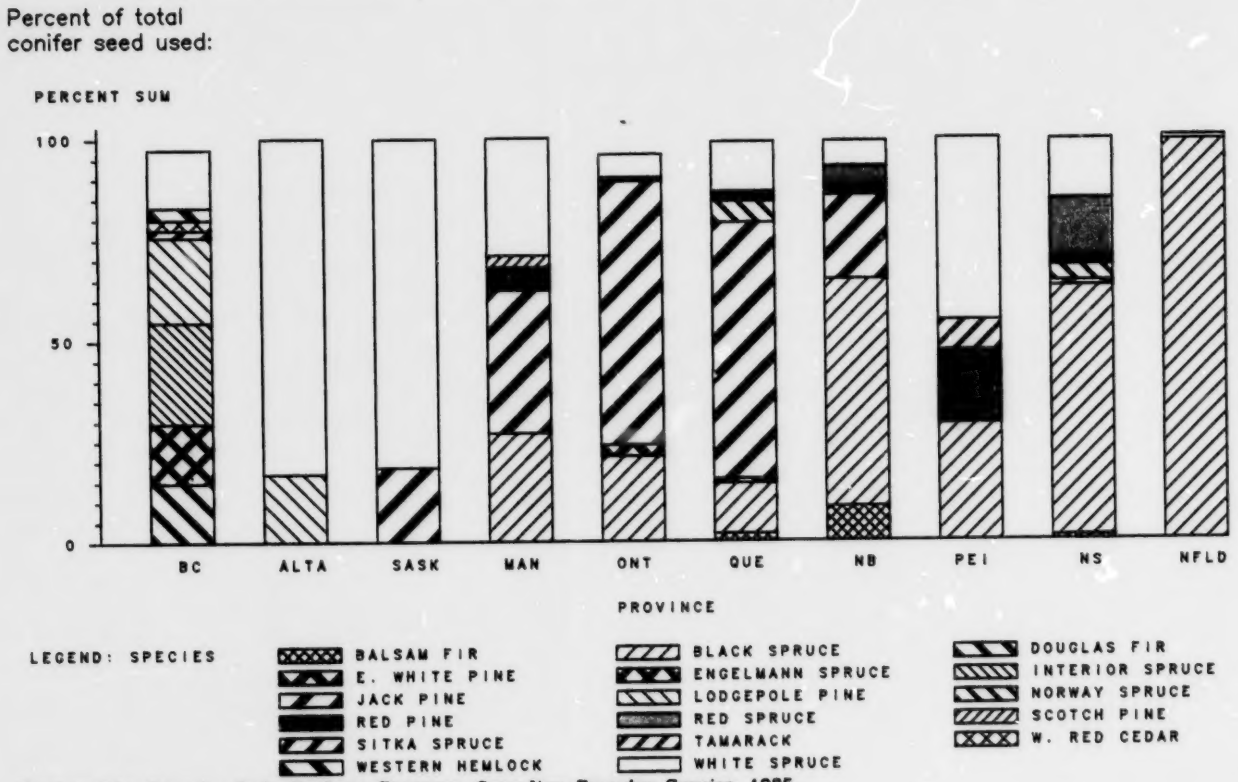
- nil

Table 6. (continued)

| Species | Province | Volume collected (hl) | Yield[1] | | | Seed utilized | | Seed in storage | |
|---|---|---|---|---|---|---|---|---|---|
| | | | kg | kg/hl | viable seed/hl | kg | viable seed x $10^6$ | kg | viable seed x $10^6$ |
| white spruce | Alberta | 5996 | 6579 | 1.12 | 374 250 | 2576 | 743.2 | 30 484 | 8793.5 |
| | British Columbia | 353 | 338 | 0.96 | 313 050 | 152 | 49.7 | 2506 | 819.4 |
| | Manitoba | 10 | 8 | 0.79 | 191 140 | 24 | 8.0 | 219 | 79.3 |
| | New Brunswick | 125 | 97 | 0.78 | 233 890 | 95 | 22.0 | 1140 | 334.5 |
| | Newfoundland | 145 | 102 | 0.70 | 249 230 | 2 | 0.6 | 100 | 35.6 |
| | Nova Scotia | 250 | 197 | 0.79 | 118 640 | 63 | 11.9 | 287 | 44.2 |
| | Ontario | 6554 | 6436 | 0.99 | 351 310 | 397 | 140.7 | 8971 | 3178.4 |
| | Prince Edward Is. | 17 | 23 | 1.36 | 481 980 | 12 | 4.2 | 23 | 8.3 |
| | Québec | 1194 | 1179 | 0.99 | 301 260 | 356 | 113.6 | 2324 | 739.6 |
| | Saskatchewan | 860 | 1195 | 1.39 | 640 640 | 338 | 155.8 | 4879 | 2251.0 |
| | Totals | 15 504 | 16 154 | | | 4015 | 1249.7 | 50 933 | 16283.8 |
| | Weighted Mean | | | 1.04 | 365 900 | | | | |

[1]Calculation based on volume of cones processed in reporting year, not necessarily volume collected in that year.
N/A not available
- nil

***Figure 1.*** **Most important reforestation species in each province, based on number of seed utilized in 1982/83.**




*Produced by Forestry Data Systems Program, Canadian Forestry Service, 1985.*

**Table 7. Cone collection of major reforestation species by production strategy for 1982/83**

| | Seed yield (viable seed x10⁶) | | | % Yielded by | | |
|---|---|---|---|---|---|---|
| | G/SZ[1] | SCA/SPA[2] | SO[3] | G/SZ | SCA/SPA | SO |
| Douglas-fir | 142.8 | 44.7 | 19.8 | 68.9 | 21.6 | 9.6 |
| jack pine | 2000.2 | 1181.6 | - | 62.9 | 37.1 | - |
| lodgepole pine | 858.2 | 4.9 | 0.4 | 99.4 | 0.5 | - |
| red pine | 41.2 | 2.8 | - | 93.7 | 6.3 | - |
| white pine | 134.1 | - | - | 100 | - | - |
| black spruce | 2225.9 | 65.1 | - | 97.2 | 2.8 | - |
| Engelmann spruce | 280.6 | 88.7 | - | 76.0 | 24.0 | - |
| interior spruce | 181.6 | 142.7 | - | 56 | 44 | - |
| Norway spruce | 69.2 | - | - | 100 | - | - |
| white spruce | 5518.7 | 88.7 | 0.8 | 98.4 | 1.6 | - |
| totals | 11452.5 | 1619.2 | 21.0 | 87.5 | 12.4 | 0.2 |
| 1980/81 totals | 5468.4 | 707.1 | 12.3 | 88.4 | 11.4 | 0.2 |

- nil.
[1] general/seed zone collections.
[2] seed collection areas/seed production areas.
[3] seed orchards.

species based on number of hectares of seed orchards per species from Pollard's 1981 survey, it is calculated that if all of these orchards are in production by 1997, up to 210.6 x $10^6$ viable seed or 4.6% of seed yield in that year (projecting current seed yield for the top 10 species into the future) will originate from seed orchards.

**Tree seed extraction plant directory**

A total of 14 forest tree seed extraction plants are listed in Appendix I. Three of these are privately operated.

To ensure a continuous supply of high quality seed for reforestation, seeds must be properly stored. Seed storage temperatures vary between +2°C to -18°C in the 12 seed banks, with subfreezing temperatures reported by 10 of these facilities. Seed moisture contents range from 3% to 9%, with most stations reporting an average of 6%. Subfreezing temperatures and low moisture contents (below 8%) were recommended by Wang (1974) for satisfactory storage of most conifer species. The most popular containers used for seed storage are high density polyethylene carboys, of 20 litre size, with plastic screw caps. Some extraction plants reported using 4 to 5 mil plastic bags stored in waxed cardboard boxes. Of the 12 seed storage facilities, 10 included white spruce, 8 included black spruce, and 8 have jack pine in their inventories.

## SUMMARY AND CONCLUSIONS

Highlights of the 1982/83 national seed survey are presented below:

(1) The 10 leading species in reforestation in Canada in descending order of importance based on number of seed used are jack pine, white spruce, black spruce, lodgepole pine, interior spruce, white pine, Norway spruce, Douglas-fir, red pine, and Engelmann spruce.

(2) Among Canadian provinces, the 10 species with the most widespread use in descending order with number of provinces reporting use in brackets are: white spruce (10), black spruce (7), jack pine (6), red pine (6), balsam fir (5), Japanese larch (4), tamarack (4), eastern white pine (4), red spruce (4), and Norway spruce (3).

(3) The number of viable seed used in coniferous reforestation activities during 1982/83 in Canada was 5.3 billion, comprising 34 species. Hardwoods accounted for less than 0.1% of total seed sown.

(4) Seed utilization has declined 7.3% since the previous survey. It is, therefore, necessary that seed use be increased by 6.6% annually to achieve the reforestation requirement of 7.3 billion seeds by 1987.

(5) Substantial increases in volume of cones collected and processed and amount of seed in storage have been registered since the last survey, indicating that seed supply does not appear responsible for the decline in seeds utilized. Seed yield from processed cones totaled 14.3 billion and substantially exceeded total seed utilized.

(6) The bulk of seed used continues to be genetically unimproved, with only 12.4% and 0.2% of seed originating from seed production/collection areas and seed orchards, respectively.

(7) Eleven government-owned and three privately-operated seed extraction plants processed cones and seed for reforestation purposes in 1982/83. Twelve reported having seed storage facilities, most of these with sub-freezing temperatures and conifer seeds stored with moisture contents of 6% in rigid-walled polyethylene containers.

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## APPENDIX I

**Reforestation-oriented tree seed extraction plants in Canada**

| Ownership category P=provincial I=industry | Mailing address Supervisor Phone number | Production capacity (hl) D=daily Y=yearly | SEED STORAGE FACILITY | | | | |
|---|---|---|---|---|---|---|---|
| | | | Clean seed storage capacity (kg) | Major species stored | Storage conditions | | |
| | | | | | Temperature (°C) | Moisture content (%) | Container type |
| P | B.C. Ministry of Forests<br>Duncan Seed Centre<br>5847 Chesterfield St.<br>Duncan, B.C. V9L 3M5<br>Mr. R. Bowden-Green<br>(604) 748-5133 | 45 (D) | 35000 | Abies amabilis, A. grandis, A. lasiocarpa, Chamaecyparis nootkatensis, Larix occidentalis, Picea engelmannii, P. glauca, P. mariana, P. sitchensis, Pinus albicaulis, P. contorta, P. monticola, P. ponderosa, Pseudotsuga menziesii, Tsuga mertensiana, T. heterophylla, Thuja plicata | -15 to -18 | 5-9 | 4 mil plastic bag sealed in waxed cardboard box |
| P | B.C. Ministry of Forests<br>Redrock Nursery<br>R.R. #7, 15 Mile Road<br>Prince George, B.C. V2N 2J5<br>Mrs. H. Rooke<br>(604) 748-5133 | 3.5 (D) | None | None reported | | | |
| I | Reid, Collins and Associates Ltd.<br>P.O. Box 430<br>Aldergrove, B.C. V0X 1A0<br>Mr. L.M. Glen<br>(604) 533-2212 | 16-30 (D) | 2760 (8.6 m³) | Abies grandis, Pinus contorta, P. monticola, P. ponderosa, Pseudotsuga menziesii, Thuja plicata | -5.5 | ±7 | Plastic bags in waxed boxes |

Appendix I (continued)

| Ownership category P=provincial I=industry | Mailing address Supervisor Phone number | Production capacity (hl) D=daily Y=yearly | SEED STORAGE FACILITY: Clean seed storage capacity (kg) | Major species stored | Storage conditions: Temperature (°C) | Moisture content (%) | Container type |
|---|---|---|---|---|---|---|---|
| I | Silva Enterprises Ltd.<br>1296 Freeman Street<br>Prince George, B.C. V2M 2R8<br>Mr. R. Hellenius<br>(604) 563-3250 | 16-18 (D) | 120<br>(0.6 m³) | None reported | | | |
| I | Western Tree Seeds Ltd.<br>P.O. Box 144<br>Blind Bay, B.C. V0E 1H0<br>Mr. F.D. Barnard<br>(604) 675-2463 | 35-45 (D) | (3.5 m³) | Abies grandis, A. lasiocarpa, Picea engelmannii, P. glauca, P. sitchensis, Pinus contorta, P. monticola, P. ponderosa, Pseudotsuga menziesii, Thuja plicata, Tsuga heterophylla | -8 | 6-8 | Cardboard cartons with a tightly tied "poly" liner |
| P | Energy and Natural Resources<br>Pine Ridge Forest Nursery<br>P.O. Box 750<br>Smoky Lake, Alberta T0A 3C0<br>Mr. H.R. Winn<br>(403) 656-4130 | 259 (D) | 60 000 | Abies balsamea, Picea engelmannii, P. glauca, P. mariana, P. pungens, Pinus albicaulis, P. banksiana, P. contorta, P. flexilis, Pseudotsuga menziesii | -18 | 4-8 | 5 mil plastic bags, heat sealed and placed in waxed cardboard boxes, covered with a separate cover, making it a two layer waxed cardboard container |

Appendix I (continued)

| Ownership category P=provincial I=industry | Mailing address Supervisor Phone number | Production capacity (nl) D=daily Y=yearly | SEED STORAGE FACILITY | | | | |
|---|---|---|---|---|---|---|---|
| | | | Clean seed storage capacity (kg) | Major species stored | Storage conditions | | |
| | | | | | Temperature (°C) | Moisture content (%) | Container type |
| P | Dep. Parks and Renewable Resources<br>Forestry Division<br>Box 3003<br>Prince Albert, Saskatchewan<br>S6V 6G1<br>Mr. L. Rempel<br>(306) 764-9119 | 30 (D) | 10 000 | Picea glauca, Pinus banksiana | -18 | 3-5 | 20 L polyethylene rectangular containers with screw caps |
| P | Pineland Provincial Forest Nursery<br>Dep. Natural Resources<br>Box 45<br>Hadashville, Manitoba ROE 0X0<br>Mr. R. Cameron<br>(204) 426-5235 | 5400 (Y) | 3500 | Larix sibirica, Picea glauca, P. mariana, Pinus banksiana, P. resinosa, P. sylvestris | 1-2 | 4-8 | Polyethylene carboys in 5 sizes from 4 to 36 L |
| P | Ministry of Natural Resources<br>Dryden Tree Nursery<br>P.O. Box 90<br>Wabigoon, Ontario P0V 2W0<br>Mr. T.R. Myland<br>(807) 938-6326 | 11 000 (Y) | 15 000 | Pinus banksiana | -2 | 5-7 | Airtight polyethylene water jugs |

Appendix I (continued)

| Ownership category P=provincial I=industry | Mailing address Supervisor Phone number | Production capacity (hl) D=daily Y=yearly | SEED STORAGE FACILITY | | | | |
|---|---|---|---|---|---|---|---|
| | | | Clean seed storage capacity (kg) | Major species stored | Storage conditions | | |
| | | | | | Temperature (°C) | Moisture content (%) | Container type |
| P | Ministry of Natural Resources<br>Ontario Tree Seed Plant<br>Box 70<br>Angus, Ontario L0M 1B0<br>Mr. B. Swaile<br>(705) 424-5311 | 16 300 (Y) | 32 000 | Picea glauca, P. mariana, Pinus banksiana, P. resinosa, P. strobus | -3 | 5-8 | Polyethylene containers covered with seal & screw cap; some hardwoods stored in glass jars with screw cap |
| P | Pépinière forestière de Berthierville<br>1690 Grande Côte<br>C.P. 540<br>Berthierville, P.Q. J0K 1A0<br>Dr. J.P. Campagna<br>(514) 836-3788 | 12 800 (Y) | 4 billion seeds | Abies balsamea, Larix laricina, Picea abies, P. glauca, P. mariana, P. rubens, Pinus banksiana, P. resinosa, P. strobus, P. sylvestris | 3-4 | 5-7 | 20 L high density polyethylene containers holding 12-15 kg of seed |
| P | Maritime Forest Seed Centre<br>R.R. #6<br>Fredericton, N.B. E3B 4X7<br>Mr. N.H. Kreiberg<br>(506) 453-9103 | 4500 (Y) | 6000 | Abies balsamea, Larix laricina, Picea abies, P. glauca, P. mariana, P. rubens, Pinus banksiana, P. nigra, P. resinosa, P. sylvestris, P. strobus | -2 to -5 | 4-8 | Heavy gauge polyethylene containers with air-tight screw caps, 18 L capacity |

Appendix I (continued)

| Ownership category P=provincial I=industry | Mailing address Supervisor Phone number | Production capacity (hl) D=daily Y=yearly | SEED STORAGE FACILITY | | | | |
|---|---|---|---|---|---|---|---|
| | | | Clean seed storage capacity (kg) | Major species stored | Storage conditions | | |
| | | | | | Temperature (°C) | Moisture content (%) | Container type |
| P | Tree Breeding Centre<br>Dep. Lands and Forests<br>Debert, N.S. B0M 1G0<br>Mr. T.J. Mullin<br>(902) 662-3300 | (Research facility) | 1500 | Abies balsamea, Larix laricina, Picea glauca, P. mariana, P. rubens, Pinus banksiana, P. resinosa, P. strobus | -10 to -12 (long-term)<br>3-4 (short-term) | 5-8 | (1) heavy walled polyethylene bottles with gasketed lids<br>(2) glass preserving jars<br>(3) small glass vials and heavy walled plastic bags |
| P | Wooddale Provincial Tree Nursery<br>Dep. Forest Resources and Lands<br>P.O. Box 616<br>Grand Falls, Nfld. A2A 2K2<br>Mr. T. McDonough<br>(709) 489-3012 | 1000 (Y) | 1000 | Abies balsamea, Larix spp., Picea glauca, P. mariana, Pinus resinosa, P. strobus | -10 | 6-7 | Heavy duty polyethylene containers with plastic lids |

## APPENDIX II

### FOREST RESOURCE DATA PROGRAM - SEED PROCUREMENT AND PROCESSING QUESTIONNAIRE



REPORTING YEAR[1]: _____ CFS REGION: _____

PROVINCE OR TERRITORY: _____ REPORTED BY: _____

List of species collected for purposes of forest regeneration or establishment:
(Please list by scientific names, using additional pages if more than four species are reported).

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Volume of cones collected in reporting year | | | | | | |
| (A) Collection agency: | (i) | Provincial/Territorial governments | (hectolitres) | | | |
| | (ii) | Forest industries | (hectolitres) | | | |
| (B) Collection type: | (i) | Collection zones[2] | (hectolitres) | | | |
| | (ii) | Seed collection/Seed production areas[3] | (hectolitres) | | | |
| | (iii) | Seed orchards[4] | (hectolitres) | | | |
| Volume of cones processed in reporting year | | | | | | |
| Collection type | (i) | Collection zones | (hectolitres) | | | |
| | (ii) | Seed collection/Seed production areas | (hectolitres) | | | |
| | (iii) | Seed orchards | (hectolitres) | | | |
| Clean seed yield from cones processed in reporting year | | | | | | |
| Collection type | (i) | Collection zones | (kilograms)[5] | | | |
| | | | (number of viable seeds) | | | |
| | (ii) | Seed collection/Seed production areas | (kilograms) | | | |
| | | | (number of viable seeds) | | | |
| | (iii) | Seed orchards | (kilograms) | | | |
| | | | (number of viable seeds) | | | |

[1] Please specify the summary time frame, i.e. calendar year, fiscal year, etc.
[2] Collections identified only as to administrative district or seed zone.
[3] A plus stand which is subjected to periodic removal of undesirable individuals (roguing) and to cultural treatments for abundant seed production.
[4] A plantation of seedlings or vegetatively propagated trees established primarily for the production of seed of proven genetic quality.

[5] Viable seed can be calculated with this formula:

$$\text{viable seed} = \frac{(10000)\ (\%\ \text{germination})\ (\text{quantity in kg})}{\text{weight of 1000 seeds in grams}}$$

**FOREST RESOURCE DATA PROGRAM - SEED PROCUREMENT AND PROCESSING QUESTIONNAIRE**

REPORTING YEAR: _____ CFS REGION: _____

PROVINCE OR TERRITORY: _____ REPORTED BY: _____

Seed use in reporting year[6]

| | | | | | | |
|---|---|---|---|---|---|---|
| Domestic use: | (i) | Collection zones | (kilograms) | | | |
| | | | (number of viable seeds) | | | |
| | (ii) | Seed collection/Seed production areas | (kilograms) | | | |
| | | | (number of viable seeds) | | | |
| | (iii) | Seed orchards | (kilograms) | | | |
| | | | (number of viable seeds) | | | |

Seed inventory at end of reporting year[7]

| | | | | | | |
|---|---|---|---|---|---|---|
| Collection type | (i) | Collection zones | (kilograms) | | | |
| | | | (number of viable seeds) | | | |
| | (ii) | Seed collection/Seed production areas | (kilograms) | | | |
| | | | (number of viable seeds) | | | |
| | (iii) | Seed orchards | (kilograms) | | | |
| | | | (number of viable seeds) | | | |

Remarks:

[6] Amount of seed per species withdrawn from storage or current year's collection for nursery sowing, greenhouse sowing, direct seeding, etc.
[7] Amount of clean seed in storage at end of reporting year.

**FORREST RESOURCE DATA PROGRAM - SEED PROCUREMENT AND PROCESSING QUESTIONNAIRE**



**REPORTING YEAR:** _____ CFS REGION: _____

**PROVINCE OR TERRITORY:** _____ REPORTED BY: _____

LIST OF FOREST TREE SEED EXTRACTION PLANTS

| **Ownership[a] category** | Mailing address[b]<br>Phone number<br>Supervisor | Daily production capacity (hectolitres) | Clean seed storage capacity (cubic metres) |
|---|---|---|---|

SIGNATURE: _____ DATE: _____

[a] Three symbols are used to designate forest tree seed extraction plant ownership:
P - Provincial F - Federal I - Industry

[b] Including name of agency.

## APPENDIX III

**Most important reforestation species in each province based on number of seed utilized in 1982/83**

| Province | Species | Percentage of Total Conifer Seed Used |
|---|---|---|
| British Columbia | interior spruce | 25.0 |
| | lodgepole pine | 21.1 |
| | Douglas-fir | 14.8 |
| | Engelmann spruce | 14.8 |
| | white spruce | 14.3 |
| | western hemlock | 3.0 |
| | western red cedar | 2.6 |
| | sitka spruce | 1.8 |
| Alberta | white spruce | 83.0 |
| | lodgepole pine | 17.0 |
| Saskatchewan | white spruce | 81.3 |
| | jack pine | 18.6 |
| Manitoba | jack pine | 35.4 |
| | white spruce | 29.0 |
| | black spruce | 27.1 |
| | red pine | 5.7 |
| | Scots pine | 2.9 |
| Ontario | jack pine | 65.2 |
| | black spruce | 21.2 |
| | white spruce | 5.8 |
| | e. white pine | 2.8 |
| | red pine | 1.0 |
| Quebec | jack pine | 63.4 |
| | black spruce | 12.5 |
| | white spruce | 12.4 |
| | Norway spruce | 5.3 |
| | balsam fir | 1.9 |
| | red pine | 1.7 |
| | e. white pine | 1.2 |
| | red spruce | 1.2 |
| New Brunswick | black spruce | 56.4 |
| | jack pine | 20.7 |
| | balsam fir | 8.5 |
| | white spruce | 6.3 |
| | red spruce | 5.0 |
| | red pine | 2.2 |
| PEI | white spruce | 45.2 |
| | black spruce | 29.1 |
| | red pine | 18.0 |
| | tamarack | 7.5 |
| Nova Scotia | black spruce | 61.8 |
| | white spruce | 14.8 |
| | red spruce | 14.6 |
| | Norway spruce | 3.9 |
| | red pine | 1.9 |
| | jack pine | 1.3 |
| | balsam fir | 1.1 |
| Newfoundland | black spruce | 99.0 |
| | white spruce | 1.0 |

## APPENDIX IV

### Glossary of Terms Used

GENERAL/SEED ZONE COLLECTION: identified only as to administrative district or seed zone; actual collection locations can occur within a wide area of seed zone.

SEED COLLECTION AREA: is a visually superior stand, selected to provide an immediate supply of large amounts of source-identified seed. Management of such areas is absent or minimal and seed is obtained by destructive collection methods (i.e. felling).

SEED PRODUCTION AREA: consists of an above average quality natural or planted stand which is upgraded by removal ("roguing") of visually undesirable individuals and is cultured to provide better genetic quality and larger quantities of seed.

SEED ORCHARD: is a plantation of seedlings or vegetatively propagated individuals established for the production of proven and high genetic quality seed in substantial quantities.

SEROTINOUS: pertains to cones remaining closed on the tree for a year or more after maturity.

VIABLE SEED: seeds which, based on results of germination tests, are capable of germinating.